# Heat Exchanger Inspection

The Heat Exchanger Inspection article provides you information about inspection of heat exchanger and heat exchanger testing during construction phase as well as in operational phase.

This article provides you lots of invaluable information about following items:

- Inspection and Testing During Manufacturing Phase
- Inspection and Testing During operation Phase
- Heat Exchanger Codes and Regulations
- Maintenance and Repairs



This article alongside other linked articles are useful for Manufactures Quality Control personnel, Second and Third Party Inspectors, Purchasers, Sellers, Plant Inspectors, HSE Engineers, Integrity Engineers, Operation and Maintenance Engineers and any Other Interested Individuals.

We need to heat or to cool process fluids in industrial plants to facilitate process reactions.

So we need to use heat exchangers either reduce the temperature or increase the temperature.

For more detail review Heat Exchanger Theory article.

This article provides informationan only about shell and tube heat exchanger inspection for fin tube heat exchanger inspection review following articles:

Fin Tube Heat Exchanger Inspection

Third Party Inspection for Fin Tube Heat Exchanger

Inspection and Test Plan for Fin Tube Heat Exchanger

The content covers the shop inspection requirements during manufacturing process and In-service Inspection requirements in the operational plants.

**What is the Shell and Tube Heat Exchangers?**

Shell and Tube heat exchangers are most popular type in industry. This type is made from 3 components as below:


1. Two heads, one rear head and the other one stationary head
2. Shell
3. Tube

One fluid is in tube side and the other one in the shell side. The heat transfer is done through tube wall.

So your heat exchanger with more tubes will have more heat transfer surfaces and in the same time with higher heat exchanger diameter.

There are different kinds of shell and tube heat exchangers with different applications.

The reason for high amount of application of this kind is the easy maintenance method.

In addition shell and tube heat exchanger is the only type which can be designed and operate in the temperature of higher than 360 degree centigrade as well as in pressure higher than 30 bar.

**What are Shell and Tube Heat Exchanger Inspection Requirements in Construction Shop?**

The construction code for shell and tube heat exchangers is ASME Code Section VIII and it covers the minimum requirements for design, materials, fabrication, inspection, testing, and preparation for initial delivery.

You may know after 2003 addenda of ASME Code Section VIII Div. 1, the design of shell and tube need to be done based Subsection C in UHX part and design base TEMA or any similar code and standards is not allowed.

So this is when you require your shell and tube heat exchanger meet ASME Code requirement or when you need your heat exchanger to be “U” stamped.

As you may know heat exchangers are also pressure vessels based ASME Code requirement and all requirements for other type of pressure vessels also apply for heat exchangers.

For more detail about Stamped pressure vessels and requirements, review the Pressure Vessel Certification article.

With above explanation your inspection and test plan (ITP) for shell and tube heat exchanger need to meet the requirements of ASME Code Section VIII.

for more detail about heat exchanger inspection in construction process review follwing articles:

Third Party Inspection for Shell and Tube Heat Exchanger

Inspection and Test Plan for Shell and Tube Heat Exchanger

**What are In-Service Inspection Requirements for Shell and Tube Heat Exchanger Inspection?**

The In-Service Inspection code for your shell and tube Heat exchangers similar to other pressure vessel is API STD 510.

The other API recommendation practices and codes are also necessary to be used in conjunction of this Code.

Some of these Recommend Practices are API RP 572, API RP 577, and API RP 571 and also construction code sections might be used such as ASME Code Section VIII, ASME Code Section IX.

For Repair the requirement of API STD 510, or ASME-PCC-2 need to be met.

The title of ASME-PCC-2 which first edition published in 2006 is: “Repair of Pressure Equipment and Piping”

Please note if your shell and tube Heat exchanger is “U” stamped and you need to do repair, so you have to use Repair Organization holding “R” Stamp from National Board Inspection Code.

The API 510 Pressure Vessel Inspectors are qualified persons to do shell and tube Heat Exchanger Inspection.

You may also review Industrial Plant Inspection article.

**What are Important Items in the Shell and Tube Heat Exchanger Inspection in Overhaul ?**

Shell and Tube Heat exchanger Inspection are categorized to following items:

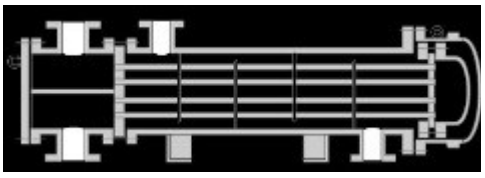
**Shell and Structure in Heat Exchanger Inspection:**

- Neutralization of Austenitic Stainless Steel shell, clads, liner or weld overlay which contains H2S service. The process need to be done based approved procedure by corrosion engineer

- Neutralization also require for shell material with admiralty brass to reduce the risk of SCC.
- Neutralization of thermocouples if necessary and doing dye penetration test
- Sampling from shell fouling and corrosion products and making lab analysis and making interpretation by corrosion engineer (if necessary)
- Cutting small area of insulation sheet and removing the insulation and doing visual inspection for any sign of corrosion under insulation
- Thickness measurement of different parts of shell and shell nozzles and making corrosion rate and remaining life calculation
- Inspection of shell cleaning and approval i.e. water jetting etc.
- Checking inside surface for any cladding, liner failure or separation
- Inspection of Shell flange gasket seating area for any erosion, damage and cracking
- Inspection of longitudinal and circumferential weld joints, inlet and outlet nozzles, reinforcement pads and small bore connections for any crack, corrosion and mechanical damage and deformation
- Dye penetration test on susceptible weld joints to the cracking, austenitic flange face, weld overlay and cladding surface and exchangers exposed to amine and caustic
- Hydrogen blistering inspection in hydrogen services (hand lamp procedure)
- Heat exchanger support, steel structure, foundation, bolt and nut inspection

**Bonnet in Heat Exchanger Inspection:**

- Thickness measurement and making corrosion rate and remaining life calculation



- Girth flange inspection for corrosion and erosion
- Internal surface inspection for corrosion and fouling
- Painting inspection of external surface
- Dye penetration or magnetic particle examination of weld joints susceptible to cracking

**Tube Bundle in Heat Exchanger Inspection**

- Taking care in the pulling out of tube bundle to avoid any mechanical damage
- Sampling from tube side fouling and corrosion products and making lab analysis and making interpretation by corrosion engineer (if necessary)
- Controlling of water jetting or lancing cleaning process
- Controlling wire brushing process of inner tube edge and rolling area (preparation for ID measurement)
- Inside diameter measurement in tubes and tubes rolling areas
- Rate off and accordingly Plugging the tubes which their OD reaches to the ID plus one thickness
- Retubing of tube bundle if more than 10% of tubes reaches to above rejection limit

- Inspection from tube bundle components such as tubesheet, tube, tie rods and spacers, transfer baffles or support plate, impingement baffle, floating head flange and floating head backing device
- Inspection from internal surface of tubes for corrosion and fouling


- Pulling out a sample tube for sectioning and corrosion analyzing if necessary
- Retubing when sectioning result proves the thickness is the half of the nominal value
- Visual inspection and dye penetration test from tube to tubesheet seal or strength weld
- Eddy current testing if it is necessary

**Channel in Heat Exchanger Inspection:**

- Thickness measurement and making corrosion rate and remaining life calculation
- Inspection of gasket seating area, pass partition and nubbing for corrosion and deformation
- Inspection of internal surface for fouling, corrosion and soundness of linings (if any)
- Balance hole inspection for corrosion and erosion

- Welding joints inspection for any possible cracks
- Reinforcement pad inspection and doing soap test if necessary
- Cathodic protection anodes inspection and replacement if necessary
- Diaphragm and division box visual inspection and dye penetration test of diaphragm for any possible cracks (for high pressure exchangers)

**Channel Cover in Heat Exchanger Inspection:**

- Thickness measurement and making corrosion rate and remaining life calculation
- Inspection of gasket seating area for corrosion and deformation
- Inspection for internal surface for fouling, liner, cladding and coating soundness
- Soap test in channel cover with liner
- Lifting lug weld joint inspection for any possible crack

**Floating Head Inspection:**

- Thickness measurement and making corrosion rate and remaining life calculation
- Inspection of gasket seating area, pass partition and nubbing for any possible corrosion and deformation
- Girth flange weld joint inspection for any possible crack and corrosion
- Internal surface inspection for corrosion and fouling and soundness of liner, coating and cladding (if any)

**Expansion Joint Inspection:**

The heat exchangers with expansion joints need to be inspected for:

- Flange inspections for corrosion and erosion
- Inspection from internal surface for corrosion and erosion
- Air test

The tube and shell hydrostatic test need to be done after above stated inspection activities.

# Heat Exchanger Theory

The Heat Exchanger Theory article provides you information about fundamental of heat exchanger and will be useful for heat exchanger inspection concept.

To describe this Theory, you may know we need to heat or to cool process fluids in industrial plants to facilitate process reactions.

So we need to use heat exchangers either to reduce the temperature or increase the temperature.

This article provides you simple explanation about heat exchangers working mechanism and applications.

Our process temperature needs to be in certain value and to be stable.

For process requirement sometime we need increase fluid temperature and sometime reduce.

For temperature reducing purpose an intermediate fluid such as cooling water, chilled water, refrigerant and air are used.

Air-cooled heat exchangers are the same which are used air as intermediate fluid.

In heat exchanger theory we need to define Indirect Heat Transfer.

In most of heat exchangers two fluids are exchanging their heat without direct physical contact to avoid from mixing. This is named indirect heat transfer.

Cooling water temperature in hot area normally is above 25 degree centigrade and it depends to atmospheric and climate condition. To reach the range of 1 to 5 degree centigrade, we need to use child water which it already cooled by refrigerant.

To reach the sub-zero temperature, we need to use refrigerant fluid alone such as R-11 or propylene.

For heating purpose the mechanism is similar to the cooling, we can use hot intermediate fluid such as hot water or steam even by other hot process stream.

To proceed on heat exchanger theory we need to know about meaning of following terminologies:

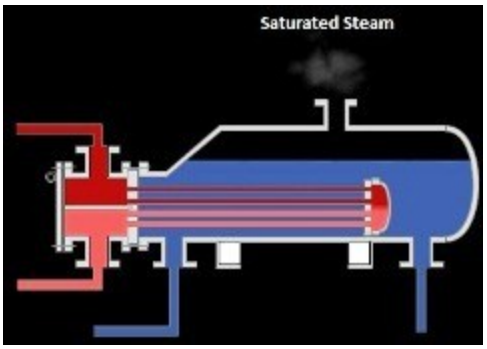
**Sensible Heat:**

The Sensible heat is amount of heat which a material can exchange without changing its phase.

For example water with 25 degrees centigrade enters to the heat exchanger and absorbs the process fluid heat and exit from the heat exchanger with 35 degree centigrade.

**What is latent Heat?**

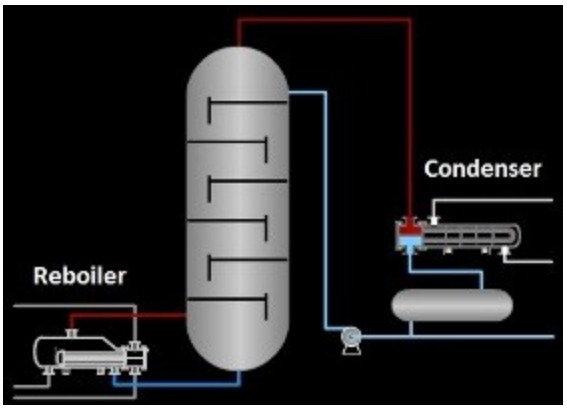
The latent heat is amount of heat transfer which a material exchanges during the change from liquid phase to the vapor phase.




Refer to above definition we are using saturated steam in heat exchangers, the saturated steam converted to liquid phase and released heat will heat our process fluid.

Indirect heat transfers are done in different heat exchangers such as coolers, heaters, reboilers and condensers.

We are naming it indirect because two fluids during the heat transfer process are not mixing together, the heat transfer are done through a metallic surface.




In above; the heat exchanger which we are using to eliminate latent heat is named condenser and;

the one is used to supply steam and heat to distillation tower is named reboiler. We will discuss about them in detail in coming paragraphs.

In all of them we are using an intermediate fluid for heat transferring; for condenser it is cooling water and in the reboiler it is steam.

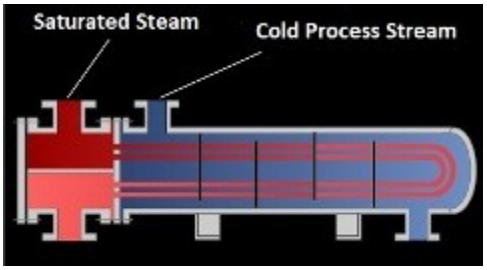
For cooler heat exchanger cooling water, refrigerants such as R-11, Propylene and propane are used.

For heater heat exchangers steam with different pressure are used. In heat exchanger theory for reducing energy consumption sometimes process fluid are used for heat transfer themselves.

For example outlet of a reactor need to be cooled in the same time inlet of reactor feed need to be heated so in this case a heat exchanger can be designed to transfer the heats between two process streams and save energy consumption.

In above example the steam will not be used for reactor feed and also cooling water not be used for reactor product. So energy remarkably will be saved.

The heat exchangers are built in way which cold and hot fluid separated by metallic surface to avoid the mixing.




These metallic surfaces are different in different heat exchanger types.

The metallic surface in shell and tube, and air-cooled heat exchanger is tube wall and in the plate heat exchanger is thin wall plate which each process fluid is in different side.

The heat transfer inside of process fluids are done by convection mechanism and in metallic surface are done by conduction mechanism.

**What is Convection Mechanism?**

Have you asked yourself how your room gets warm when you turn on your heater?

The air around of your heater is heated, this will cause the volume to be increased and the density to be decreased so this phenomena will cause the heated air to start moving upside;

then cold air which has higher density will be replaced, so this cycling cause you room gets warmed.

This was simple explanation of convection mechanism which only happens in fluids.

The mechanism is similar when you heating water in tea pot, cycling of cold and hot water and finally reaching to boiling temperature.

The same mechanism happens in process fluid in heat exchangers theory.

**What is conduction mechanism?**

In this mechanism the heat will be transferred by atoms and ions, assume you put a metallic bar on the torch, the heat will be absorbed and atoms start moving and colliding to each other;

and this movement will continue to the neighborhood atoms and collision will continue till the heat reaches to other side of the bar and you feel burning of your hand.

The same happen in the heat exchanger tube wall, the torch in the above example is hot fluid, one side of tube wall will be heated and then with conduction mechanism the heat will be transferred to other side of tube wall which is in contact with cold fluid.

**Condenser Heat Exchanger**


Based heat exchanger theory in distillation tower, we need to liquefied vapor phase (by cooling) in top of the distillation column and return it back to the tower top side.

This process is named condensation which we convert saturated vapor to saturated liquid.

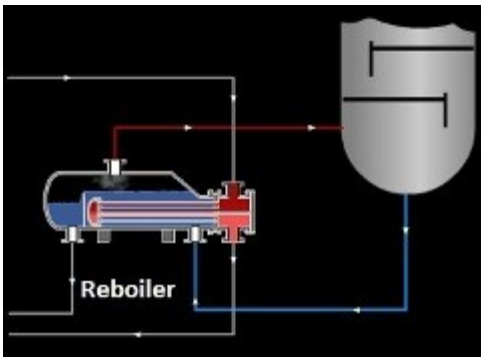
The heat exchangers which are used for condensation generally are shell and tube type and process stream is in the shell side and cooling water is in the tube side.

The vapors in the shell side gradually are changed to the liquid drops on the external surface of tubes and are collected and discharge from shell side to the column top.

Condenser can be placed in top of distillation tower and application of pump is not necessary.

But in this case maintenance and cleaning of the heat exchanger will be difficult so actually condensers are placed in the ground level and pumps are used to transfer liquid to the top of the column.

**Reboiler Heat Exchanger**




Based heat exchanger theory in distillation tower, we need to supply steam and heat to the tower bottom side. The reboilers generally are shell and tubes heat exchangers.

Process stream from tower bottom side enter to the shell side and steam enter to the tube side of the reboiler and after heat transferring the process fluid return back to the tower bottom side.

For high viscous process stream generally pumps are used to circulate process stream.


For high viscous process stream generally pumps are used to circulate process stream.

**Cooler heat exchangers**

These heat exchangers are used for cooling of process streams and generally cooling water, chilled water, air, refrigerants such as R-11 and propylene are used.

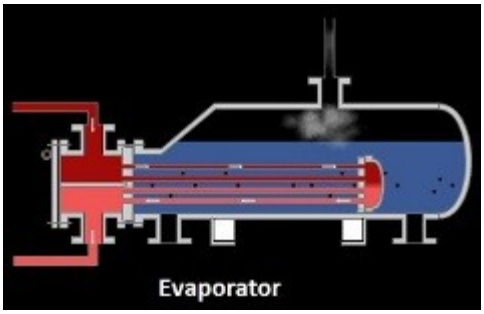
Different types of heat exchangers are used for coolers; such as air-cooled, shell and tube and plate heat exchangers.

If coolers are used for cooling of saturated vapors a knock out drum might be place before cooler to separate the liquid from vapor.

**Heater Heat Exchangers**

Based heat exchanger theory we need to heat our process fluid because of process requirements, so heater are used for these applications and normally hot water or saturated steam are used for hot side of heat exchangers.

**Evaporator and vaporizer Heat Exchangers**



In heat exchanger theory any heat transferring equipment which is used to vaporize a liquid is named vaporizer and if the liquid is water it will be named evaporator.

These heat exchangers are used to supply latent heat and their outputs always are saturated vapor.

The difference between distillation and vaporization is in the containing element, the vaporization only contain one element.


Evaporators are used for several applications such as supply of pure water for boiler feed water.

In the heat exchanger theory concept in the evaporation process, all of water will not be changed to the vapor; some percentage will be discharged from evaporator to avoid for fouling in the evaporation surface.

The water drained from evaporator is named blow down.

The produced vapor will be liquefied in the condenser heat exchanger and then will be sent to the boiler feed water tank.

# Fin Tube Heat Exchanger Inspection

The Fin Tube Heat Exchanger Inspection article provides information about air-cooled heat exchanger inspection and test in manufacturing shop as well as in operational plants.

The content covers the shop inspection during manufacturing process and In-service Inspection in the operational plants.

**What is the Air-Cooled Heat Exchangers?**

The air cooler is an exposed tube bundle unit and air is used as the cooling medium.

The fin type tubes are used for Double Pipe Coils as well as for Air Coolers.

In the air coolers the tubes are located in a steel framework and air is circulated by a fan placed either above or below the tube bank.

When the fan is above the tube bank it is named draft air cooler and when it is below the tube bank is referred to as a forced draft air cooler.

For another kind of classification there are 3 types of air coolers, header box with removable cover plate, header box with removable bonnet and header box with fixed plug sheet.

In first and second one you can access to the tube sheet similar to the shell and tube heat exchangers.

In third one you can access to the tube sheet only through plug holes.

First and second types generally are used in low pressure system and plug header is used for high pressure systems.

**What are Fin Tube Heat Exchanger Inspection requirements in Construction Shop?**

The construction code for air-cooled heat exchangers is API Standard 661 and it covers the minimum requirements for design, materials, fabrication, inspection, testing, and preparation for initial delivery.

The API Standard 661 refers you to ASME Code Section VIII for pressure components including of header boxes, tubes, and tube joints.

Specifically if your Air Cooler need to be “U” stamped, either optionally by purchaser decision or mandatory by local authority in place of installation, it is necessary to be stated in purchase order.

For more detail about Stamped pressure vessel and requirement, review the Pressure Vessel Certification article.

With above explanation your inspection and test plan (ITP) for air-cooled heat exchanger need to meet the requirements of both API Standard 661 and ASME Code Section VIII.

for more detail review following articles:

Third Party Inspection for Fin Tube Heat Exchanger

Inspection and Test Plan for Fin Tube Heat Exchanger

If you are not familiar with ITPs, click here to review Inspection and Test plan (ITP) article which explain about ITP and it connections with construction codes.

**What are In-Service Inspection Requirements for Fin Tube Heat Exchanger Inspection?**

The In-Service Inspection code for your Air-Cooled Heat exchangers similar to other pressure vessel is API STD 510. The other API recommendation practices and codes are also necessary to be used in conjunction of this Code.

Some of these Recommend Practices are API RP 572, API RP 577, and API RP 571 and also construction codes might be used such as ASME Code Section VIII, ASME Code Section IX and API STD 661.

For Repair the requirement of API STD 510, or ASME-PCC-2 need to be met.

The title of ASME-PCC-2 which first edition published in 2006 is:

“Repair of Pressure Equipment and Piping”

Please note if your Air-Cooled Heat exchanger is “U” stamped and you need to do repair, so you have to use Repair Organization holding “R” Stamp from National Board Inspection Code.

The API 510 Pressure Vessel Inspectors are qualified persons to do Fin Tube Heat Exchanger Inspection.

**What are Important items in Fin Tube Heat Exchanger Inspection in Shutdown:**

These are only important points or summery of points for Air Cooled Heat Exchanger in-service inspection and should not be assumed as inspection procedure.

Air Cooled Heat Exchanger Inspection procedure is comprehensive document which need to cover inspection methods to be employed, equipment and material to be used, qualification of inspection personnel involved and the sequence of the inspection activities as minimum.

You may use following content as summery of points for in-service inspection of Air Cooled Heat Exchanger only.

Fin Tube Heat exchanger Inspection is categorized to following items:

**Header Box and connected components Inspection:**

1. Marking Representatives Plugs which need to be opened in the shut down
2. Neutralization of Austenitic Stainless Steel header box which contains H2S service based approved procedure by corrosion engineer
3. Sampling of header box fouling and corrosion products and making lab analysis and then interpretation by corrosion engineer

4. Thickness measurement of different parts of header box such as top plate, bottom plate, end plate and making remaining life calculation
5. Dye Penetration test on heard box thermocouples
6. Visual Inspection of plug sheet and specifically plug holes gasket contact surface for any possible erosion and damage
7. Welding inspection of nozzle to flange and flange to header box welds for any possible cracking and corrosion
8. Visual inspection of inner surface of nozzles for any possible fouling and corrosion
9. Painting inspection of external surface of header box
10. Inspection of nozzles small bore connections for any possible deformation and corrosion
11. Inspection of frame, supports, plenum and earthling system
12. Specific attention to thermal expansion in start-up process and opening the header box and steel structure connection joints during the start-up process
13. Specific attention to air cooler transformation to repair shop for avoiding any possible damage to tube bundle specifically in rolling area
14. Specific attention for using new gasket for plugs

**Tube Bundle Inspection:**

1. Visual inspection of external surface of fin tubes for any possible mechanical damage and deformation
2. Sampling from tubes fouling and corrosion product and making lab analysis
3. Visual inspection for tubes edge for any possible corrosion and erosion
4. Controlling of water jetting or lancing cleaning process
5. Controlling wire brushing process of inner tube edge and rolling area (preparation for ID measurement)
6. Inside diameter measurement in tubes and tubes rolling areas
7. Rate off and accordingly Plugging the tubes which their OD reaches to the ID plus one thickness

8. Retubing of tube bundle if more than 10% of tubes reaches to above rejection limit
9. Pulling out a sample tube for sectioning and corrosion analyzing if necessary
10. Hydrostatic testing and inspection of tubes, header boxes and plugs.

## Third Party Inspection for Fin Tube Heat Exchanger

The Third Party Inspection for Fin Tube Heat Exchanger article provides you information about Fin Heat Exchangers inspection or air-cooled heat exchanger inspection in manufacturing shop.

You may need to review this article in conjunctions of following articles:

Fin Tube Heat Exchanger Inspection

Inspection and Test Plan for Fin Tube Heat Exchanger

This content guides you about all necessary stages in the production of the Fin Tube Heat Exchangers from the examination of raw material to final inspection, preservation and packing to despatch to site.

You need to take this point in account this article is written for a typical Fin Tube Heat Exchanger and might not be complete for special cases.

This content may be useful for second party inspectors, Fin Tube Heat Exchanger manufacture quality control personnel, engineering companies and purchasers as well.

All Fin Tube Heat Exchanger inspections and tests are carried out against the approved drawings, purchase order specifications, purchasers or company standards, and within the practices and rules of the country, state or province and any government decrees, laws, ordinance or regulation as may apply.

The applicable codes and specifications for Fin Tube Heat Exchanger which is under construction process are:

- Design code
- Purchase order specification
- Purchaser's standards
- Approved drawings

And applicable codes and standards are:

- ASME VIII Division 1 or 2

- API 661
- ASME V
- ASME IX

The applicable codes and standard may be based other international standards and etc. This content is general and can be useful if even the design code is different from ASME and API Code.

**Required Documents for Third Party Inspector Review:**

The list of documents normally is agreed in the Pre Inspection meeting which is hold several weeks before actual commencement of inspection work. The parties which are participated in this meeting are manufacture, purchaser and third party inspection agency representatives.

This already explained in the Inspection and Test Plan for Fin Tube Heat Exchanger article.

These are the list of documents which are normally agreed to be presented to the inspector:

- Fin Tube Heat Exchanger Manufacture Quality Control Plan
- Fin Tube Heat Exchanger Inspection and test plan
- Fin Tube Heat Exchanger Data Sheet
- Fin Tube Heat Exchanger Approved Drawings
- Fin Tube Heat Exchanger Strength calculation sheets
- Fin Tube Heat Exchanger Material Test Reports
- Fin Tube Heat Exchanger Test Data for Fans, Fan Motors, Gearboxes etc.
- Fin Tube Heat Exchanger Welding Specification Procedures (WPS) and Procedure Qualification Records(PQR)
- Fin Tube Heat Exchanger Welding Map
- Fin Tube Heat Exchanger Welders Qualifications Reports
- Fin Tube Heat Exchanger NDE procedures
- Fin Tube Heat Exchanger NDE Personnel qualifications Reports
- Fin Tube Heat Exchanger Heat treatment procedure
- Fin Tube Heat Exchanger Calibration Certificates for Test Equipment

- Fin Tube Heat Exchanger Hydrostatic Testing Procedure and Water Quality Document
- Fin Tube Heat Exchanger Preparation and Painting Procedure
- Fin Tube Heat Exchanger Preservation, Packing and Shipping Procedure
- Fin Tube Heat Exchanger Packing List

**Third Party Inspection for Fin Tube Heat Exchanger - Material Inspection**

The first actual inspection work in the Fin Tube Heat Exchanger is raw materials inspection. Based the ASME Code providing material test reports for plates is mandatory, for other components only the marking inspection will be enough.

But if purchase order has mandated the MTR to be provided for all components such as tubes, nozzle pipes, fittings and etc. then the manufacture provides them as well.

For more detail you may review the Pressure Vessel Plate article.

As mentioned in above, the original or authenticated copies of mill certificates for plates normally are at manufacturer's premises.

The third party inspector examines these certificates for compliance with specifications and where appropriate, drawings.

The review includes checks on:

- Certificate No.
- Heat or cast No.
- Chemical composition.
- Mechanical properties.
- Heat treated condition.
- NDE applied and results.

Then the inspector witnesses the plate material identification on the certificates against plate marking. It is also necessary to check with Fin Tube Heat Exchanger drawing datasheet, material list and other specification as appropriate.

The transfer identification to cut off plates also is checked.

Visual inspection for surface finish and probable defects is done and dimensional compliance with specification need also to be controlled.

Structural support, pass partition, stiffener, plug, Louvre blade pivot pins, Louvre bearings,

Steel louver blades and frames, fin, Fan blades, Plenums, fan decks, partitions, platforms and fan rings and Metal gasket materials are selected and inspected based of requirements of API 661 Clause 8.

When the third party inspector carried out the material inspection, then provides inspection visit report, the report contains following items:

- Confirmation of satisfactory document review
- Record of the endorsement of certification reviewed/witnessed
- Record of all non-conformities
- Record of any tests witnessed and the result

**Third Party Inspection for Fin Tube Heat Exchanger-Fabrication**

When the Fin Tube Heat Exchanger material inspection carried out and result was satisfactory or non-conformities closed by remedial action, then Fin Tube Heat Exchanger manufacture will be authorised to start fabrication.

The third party Inspector checks following points on Fin Tube Heat Exchanger based on the inspection and test plan (ITP) which is already agreed between purchaser and Fin Tube Heat Exchanger manufacture.

The inspection scope is determined in ITP, some clients prefer to have stringent control and put the TPI inspector in more “hold points” in fabrication activities and some others may take lesser “hold points” and put TPI much more in the review document.

This depend to the inspection budget which client assign for inspection, much more inspection will have much more costs and less risks and conversely less more inspection will have less costs but more risks.

For more detail review Inspection and Test Plan for Fin Tube Heat Exchanger article. There is draft ITP in this article which I believe it is the best practice for Fin Tube Heat Exchanger inspection.

**Third Party Inspection for Fin Tube Heat Exchanger - Preparation for Welding:**

The third party inspector carries out visual and dimensional check to ensure compliance with WPS and other specifications. Where specified, weld bevels are examined by required code method after grinding/machining.

It is necessary edges and weld bevels to be clean, dry and free from surface defects, laminations, cracks, voids, notches, etc.

These are a cause for rejection unless suitable/satisfactory remedial action can be taken. Weld repairs are carried out in accordance with the code requirements and approved by the client before welding proceeds and serious or excessive defects are reported.

Fabrication tolerances and requirement are controlled as per API 661 Clause 9.

If third party inspector is not in the hold or witness point in this stage, then will review fin tube heat exchanger manufacture quality control report in his/her coming visit or final inspection day.

**Third Party Inspection for Fin Tube Heat Exchanger - Fit-Up Inspection**

Shapes and dimensions are checked in accordance with the approved WPS and drawing.

Tack welds are produced using the applicable WPS conditions and it is necessary to be free from defects.

Magnetic Testing (MT) or Penetration Testing (PT) may be performed in accordance with the code requirement.

Similarly if third party inspector is not in the hold or witness point in this stage, then will review fin tube heat exchanger manufacture quality control report in his/her coming visit or final inspection day.

**Third Party Inspection for Fin Tube Heat Exchanger - Monitoring of Weld Conditions**

The third party inspector controls preheat heat temperature and method, Interpass temperatures, weld material control, welder and process qualifications for conformity to the code requirements.

Similarly if third party inspector is not in the hold or witness point in this stage, then will review fin tube heat exchanger manufacture quality control report in his/her coming visit or final inspection day.

**Third Party Inspection for Fin Tube Heat Exchanger - Back Gouging Inspection:**

The third party inspector controls the shape and dimensions of the back gouged groove for conformity to the WPS requirement. It is necessary the visual appearance to be clean and free from defects. NDE examination is done in accordance with the code requirement.

Similarly if third party inspector is not in the hold or witness point in this stage, then will review fin tube heat exchanger manufacture quality control report in his/her coming visit or final inspection day.

**Third Party Inspection for Fin Tube Heat Exchanger - Inspection of Completed Weld**

After completion of all welding and grinding operations a visual examination confirms there are no harmful defects such as cracks, lack of fusion, surface porosity or exposed slag inclusions, incomplete penetration, incorrect profile of the weld, lack of leg length and overlap.

Temporary attachments are removed, ground smooth, and the areas checked for defects by MP or PT for defects.

Similarly if third party inspector is not in the hold or witness point in this stage, then will review fin tube heat exchanger manufacture quality control report in his/her coming visit or final inspection day.

**Third Party Inspection for Fin Tube Heat Exchanger - Non Destructive Examination**

NDE is performed by qualified personnel to the approved techniques.

NDE technique and scope is based of clause 10.2 of API 661and acceptance criteria for any indication are based ASME Code Section VIII Div 1 or 2

The third party inspector checks that the correct method has been used and verifies the approved status of both the technique and the personnel.

Similarly if third party inspector is not in the hold or witness point in this stage, then will review fin tube heat exchanger manufacture quality control report in his/her coming visit or final inspection day.

**Third Party Inspection for Fin Tube Heat Exchanger - Weld Repair**

The Fin Tube Heat Exchanger weld repairs are completed using an approved WPS method and retested accordingly.

It is necessary all repairs approved before any post weld heat treatment is carried out.

**Third Party Inspection for Fin Tube Heat Exchanger Post Weld Heat Treatment**

The third party inspector reviews the post weld heat treatment record of temperature and time in accordance with the approved code/procedure. Similarly the results of hardness tests are reviewed in accordance with the code requirements.

**Third Party Inspection for Fin Tube Heat Exchanger Mock-Up Test of Tube to Tube-Sheet Weld**

Mock-up test is made when required by purchase order or contract. Identification, visual appearance and dimensions, weld control, PT, section of weld, Macro-observation, hardness check of weld metal and heat affected zone are checked as required.

**Third Party Inspection for Fin Tube Heat Exchanger Visual and Dimensional Inspection of Tubes, Tube Bundle, Cover Plate, Bonnet, Plug Sheet, Top and Bottom Plate and End Plate**

The third party inspector carries out following controls:

- Tube sheet and baffle plate, including tube hole, heads, flanges, tubes, flange facing finish.
- Tubes after bending for thinning particularly on the back of bends.
- Finned tubes are visually inspected to confirm that the type of finning is in accordance with the contract requirement and to ensure that assembled tubes have no damage in the finned areas. It is necessary damaged tubes to be rejected for straightening or correction before final test.
- Cover plate, top and bottom plates, tubesheet, pass partition, side frame, tube spacers, tube keepers, tube supports, nozzles and tubes assembly in Removable cover-plate header type air cooled heat exchangers.
- Bonnet, top and bottom plates, end plates, stiffeners, tubesheet, pass partition, side frame, tube spacers, tube keepers, tube supports, nozzles and tubes assembly in Removable Bonnet header type air cooled heat exchangers.
- Plug sheet, top and bottom plates, tubesheet, pass partition, side frame, tube spacers, tube keepers, tube supports, nozzles and tubes assembly in plug headers type air cooled heat exchangers.
- Direction and orientation of nozzle, lugs and external, internal fittings are checked.
- Lengths, wall thickness, straightness of header box are checked.
- Expansion ratio of tube ends is checked. Tubes are checked for thinning after expansion.
- U-tubes are formed from a single length having no circumferential welds, and flattening is not exceeding 10% of the nominal OD of tubes.
- Tube sheet flatness on gasket contact surface is checked as required.

Similarly if third party inspector is not in the hold or witness point in this stage, then will review fin tube heat exchanger manufacture quality control report in his/her coming visit or final inspection day.

**Third Party Inspection for Fin Tube Heat Exchanger Bundle Insertion**

Tube bundle insertion is checked as required. Cleanliness, insertion without binding, contact of tube sheet and shell flange and gasket used is confirmed.

Similarly if third party inspector is not in the hold or witness point in this stage, then will review fin tube heat exchanger manufacture quality control report in his/her coming visit or final inspection day.

**Third Party Inspection for Fin Tube Heat Exchanger Fan Test**

After installation each fan is tested to ensure that it is correctly installed (correct direction of rotation) and can rotate freely without fouling any part of the surrounding structure.

Similarly if third party inspector is not in the hold or witness point in this stage, then will review fin tube heat exchanger manufacture quality control report in his/her coming visit or final inspection day.

**Third Party Inspection for Fin Tube Heat Exchanger Pneumatic Test**

The third party inspector witnesses low pressure pneumatic test for nozzle reinforcing pads, support saddles or other attachments when specified by approved low pressure pneumatic test procedure using soapy water as the indicating medium.

A minimum of 1 gauge with correct working ranges as described by the code is used.

Similarly if third party inspector is not in the hold or witness point in this stage, then will review fin tube heat exchanger manufacture quality control report in his/her coming visit or final inspection day.

**Third Party Inspection for Fin Tube Heat Exchanger Hydrostatic Testing:**

The third party inspector witnesses tube side hydrostatic testing, the test is done based requirements of API 661 clause 10.3 and following points is taken in account.

- Calibration status and correct working ranges of gauges. A minimum of 2 pressure gauges are attached to item under test.
- Adequate provision for venting of high points and draining is provided.
- Test pressure is applied as directed by procedure or code until test limiting pressure is reached. During hold period, a methodical check for leaks is conducted.
- Test pressures, metal and water temperatures are recorded.

- Water quality is as specified.

Special requirements of the purchaser's specification for deflection or strain gauges or pressure/time/temperature recordings are examined by the inspector and records verified.

For more detail in hydrostatic testing review Vessel Pressure Testing article.

**Third Party Inspection for Fin Tube Heat Exchanger Performance Testing**

Where specified by the contract or purchase order the third party inspector witnesses a full performance test of the Air Cooled Heat Exchanger package including:

- Air flow through the exchanger
- Pressure drop test
- Flow test
- Power consumption
- Noise level test

**Third Party Inspection for Fin Tube Heat Exchanger - Final Inspection**

After hydrostatic testing, the vessel is thoroughly drained and dried out by approved methods.

All internal fittings, attachments, coatings or other requirements are completed.

Specified post hydrostatic test NDE is completed and the heat exchanger closed.

All Fin Tube Heat Exchangers is checked for cleanliness and dryness by an approved method.

The third party inspector rechecks nozzle, saddle and bracket locations and orientations against assembly drawings.

Third Party Inspection for Fin Tube Heat Exchanger - Name Plate

The content of the marking is checked in accordance with approved drawing and specifications by the third party inspector. It is necessary name plate to be mounted on bracket welded to shell at the height specified.

**Third Party Inspection for Fin Tube Heat Exchanger - Painting and Coating Inspection**

Surface preparation for painting is checked for the following points and meets the requirements of API 661 clause 11.2 by third party inspector:

- Cleaning method (Blast or scraping and wire brushing)
- Preparation grades
- Freedom from weld spatter, blow-holes and other defects
- Dry film thickness is checked according to specification

It is necessary surface condition to be free from pin-holes, runs damage and other discontinuity

**Third Party Inspection for Fin Tube Heat Exchanger - Spares and Accessories:**

The third party inspector control spares, tools and accessories and makes visual and dimensional inspection for materials, workmanship and quantity according to purchase order specification and packing list.

Marking and/or Tag is checked for identification.

**Third Party Inspection for Fin Tube Heat Exchanger - Reporting:**

Third party inspector provides Inspection Visit Report (IVR) after each visit as well as a final report summarising the activities carried out during the vessel production in accordance with the contract requirements and circulated within the time limits specified in the contract.

The report is in the format required by the client and clearly indicates final acceptance or rejection of the Fin Tube Heat Exchanger.

**Third Party Inspection for Fin Tube Heat Exchanger - Release Note:**

When required by the contract or purchase order a release note is issued by third party agency and given to the manufacturer when the fin tube heat exchanger have been finally accepted.

**Third Party Inspection for Fin Tube Heat Exchanger Packing, Marking and Shipping:**

The following points are checked by the third party inspector:

- Cleanliness and dryness of Fin Tube Heat Exchangers
- Rust prevention for all machined surfaces
- Protection for cover for all opening and protruding parts
- Packing style and suitably for overseas transportation
- Shipping marks and other markings and notificationof welding prohibited, etc.

- Where nitrogen purge is specified the gas pressure is checked and the presence of warning notices checked.

**Third Party Inspection for Fin Tube Heat Exchanger - Final Book (Dossier)**

The following final documents are reviewed and signed off by third party inspector:

As built, drawings if required, Manufacturer's data reports, Material certificate or certified mill test reports for all pressure parts, Material list or map, Welder record for each seam or map, Heat treatment records (Temperature-time record chart during PWHT), Dimensional record, NDE records, Production test record/mock test record, Alloy verification records, (if required), Hydrostatic test record, Pneumatic test record, Hardness test record, Tube expansion record, if required, Post weld heat treatment NDE, if specified, Name plate or other marks, Packing list, Spare parts and tool list

## Inspection and Test Plan for Fin Tube Heat Exchanger or Air-Cooled Heat Exchager

The inspection and test plan for fin tube heat exchanger or air-cooled heat exchanger article provides you information about fin tube heat exchanger inspection or air-cooled heat exchanger inspection in manufacturing shop.

Click here if you like immediately review the Inspection & Test Plan for Fin Tube Heat Exchanger draft sheet.

You may need to review this sheet in conjunction of Third Party Inspection for Fin Tube Heat Exchanger article.

The ASME Code Section VIII Div.1 and API 661 requirements normally are used for inspection and test plan for fin tube heat exchanger in manufacturing shop.

The witness of some inspection and test by third party inspector is mandatory and cannot be waived.

Some others must only monitored and fully witnessing is not necessary, for these items, the inspection man-days etc. depends to the purchaser decision, some prefer stringent monitoring and even assign resident inspector in manufacturing shop and some others relay to quality control system of the manufacture and assign only few days for monitoring points.

These are some of inspection points which need to be witnessed, checked, monitored and reviewed by third party inspector in fin tube heat exchanger manufacture shop.

**Inspection and Test Plan for Fin Tube Heat Exchanger or Air-Cooled Heat Exchanger - Important Points**

- All plates need to be identified against mill test certificates at the Vendor`s works before commencement of fabrication.

- Checking test certificates of all materials for pippins, accessories, motors, gear box.
- ensuring that welding procedure and welders are qualified before commencement of fabrication
- Where applicable, selection spots for radiography and other non-destructive tests.
- If specified witnessing any crack detection, hardness checks, ultrasonic test etc.
- Reviewing of radiographs.
- Witnessing of hydrostatic test on complete bundle.
- Dimensionally checking and carrying out final inspection of complete bundles for quality of workmanship.
- Balancing of fans need to be witnessed by Vendor. Fans to undergo an assembly running test (fan gear & motor). This test needs to be witnessed.
- Fan rings to be dimensionally checked.
- Motors to be finally inspected. This included checking of test certificates to ensure that performance tests have been carried out in accordance with applicable specifications.
- Running tests on gearboxes to be witnessed, and gearing to be examined on completion.
- Structural steel work to be checked for quality of workmanship and spot-checked for dimensional accuracy.

Click here to see Inspection & Test Plan for Fin Tube Heat Exchanger draft sheet

## Third Party Inspection for Shell and Tube Heat Exchanger

The Third Party Inspection for Shell and Tube Heat Exchanger article provides you information about Shell and Tube Heat Exchanger inspection and shell and tube heat exchanger test in manufacturing shop.

You may need to review this article in conjunctions of following articles:

Heat Exchanger Inspection

Inspection and Test Plan for Shell and Tube Heat Exchanger

This content covers all necessary stages in the production of the Shell and Tube Heat Exchangers from the examination of raw material to final inspection, preservation and packing to despatch to site.

You need to take this point in account this article is written for a typical Shell and Tube Heat Exchanger and might not be detail for special cases.

This content may be useful for second party inspectors; Shell and Tube Heat Exchanger manufacture quality control personnel, engineering companies and purchasers as well.

All Shell and Tube Heat Exchanger inspections and tests are carried out against the approved drawings, purchase order specifications, purchasers or company standards, and within the practices and rules of the country, state or province and any government decrees, laws, ordinance or regulation as may apply.

The applicable codes and specifications for the Shell and Tube Heat Exchanger which is under construction process are:

- Design code
- Purchase order specification
- Purchaser's standards
- Approved drawings

And the applicable codes and standards are:

- ASME VIII Division 1 or 2
- ASME V
- ASME IX

The applicable codes and standard may be based other international standards such as BS 5500 and etc. This content is general and can be useful if even the design code is different from ASME Code.

**Required Documents for Third Party Inspector Review:**

The list of documents normally is agreed in the Pre Inspection meeting which is hold several weeks before actual commencement of inspection work. The parties which are participated in this meeting are manufacture, purchaser and third party inspection agency representatives.

This already explained in the Inspection and Test Plan for Shell and Tube Heat Exchanger article.

These are the list of documents which are normally agreed to be presented to the inspector:

- Shell and Tube Heat Exchanger Manufacture Quality Control Plan
- Shell and Tube Heat Exchanger Inspection and test plan
- Shell and Tube Heat Exchanger Data Sheet
- Shell and Tube Heat Exchanger Approved Drawings
- Shell and Tube Heat Exchanger Strength calculation sheets
- Shell and Tube Heat Exchanger Material Test Reports
- Shell and Tube Heat Exchanger Welding Specification Procedures (WPS) and Procedure Qualification Records(PQR)
- Shell and Tube Heat Exchanger Welding Map
- Shell and Tube Heat Exchanger Welders Qualifications Reports
- Shell and Tube Heat Exchanger NDE procedures
- Shell and Tube Heat Exchanger NDE Personnel qualifications Reports
- Shell and Tube Heat Exchanger Heat treatment procedure
- Shell and Tube Heat Exchanger Calibration Certificates for Test Equipment
- Hydrostatic Testing Procedure and Water Quality Document
- Shell and Tube Heat Exchanger Preparation and Painting Procedure
- Shell and Tube Heat Exchanger Preservation, Packing and Shipping Procedure
- Shell and Tube Heat Exchanger Packing List

**Third Party Inspection for Shell and Tube Heat Exchanger - Material Inspection**

The first actual inspection work in the Shell and Tube Heat Exchanger is raw materials inspection. Based the ASME Code providing material test reports for Shell and Tube Heat Exchanger plates is mandatory, for other components only the marking inspection will be enough.

But if purchase order has mandated the MTR to be provided for all components such as tubes, nozzle pipes, fittings and etc. then the manufacture need to provide them as well.

For more detail you may review the Pressure Vessel Plate article.

As mentioned in above, the original or authenticated copies of mill certificates for plates normally are available at manufacturer's premises.

The third party inspector examines these certificates for compliance with specifications and where appropriate, drawings.

The review includes checks on:

- Certificate No.
- Heat or cast No.
- Chemical composition.
- Mechanical properties.
- Heat treated condition.
- NDE applied and results.

Then the inspector witnesses the plate material identification on the certificates against plate marking. It is also necessary to check with Shell and Tube Heat Exchanger drawing datasheet, material list and other specification as appropriate.

The transfer identification to cut off plates also needs to be checked.

Visual inspection for surface finish and probable defects need to be done and dimensional compliance with specification need also to be controlled.

For more detail in Shell and Tube Heat Exchanger raw material inspection you may review Pressure Vessel Dimension Inspection article.

When the third party inspector carried out the material inspection, then provides inspection visit report, the report contains following items:

- Confirmation of satisfactory document review
- Record of the endorsement of certification reviewed/witnessed
- Record of all non-conformities
- Record of any tests witnessed and the result

**Third Party Inspection for Shell and Tube Heat Exchanger- Fabrication**

When the Shell and Tube Heat Exchanger material inspection carried out and result was satisfactory or non-conformities closed by remedial action, then Shell and Tube Heat Exchanger manufacture will be authorised to start fabrication.

The third party Inspector checks following points on Shell and Tube Heat Exchanger based on the inspection and test plan (ITP) which is already agreed between purchaser and Shell and Tube Heat Exchanger manufacture.

The inspection scope is determined in ITP, some clients prefer to have stringent control and put the TPI inspector in more “hold points” in fabrication activities and some others may take lesser “hold points” and put TPI much more in the review document.

This depend to the inspection budget which client assign for inspection, much more inspection will have much more costs and less risks and conversely less more inspection will have less costs but more risks.

For more detail review Inspection and Test Plan for Shell and Tube Heat Exchanger article. There is draft ITP in this article which I believe it is the best practice for Shell and Tube Heat Exchanger inspection.

**Third Party Inspection for Shell and Tube Heat Exchanger - Preparation for Welding:**

The third party inspector carries out visual and dimensional check to ensure compliance with WPS and other specifications. Where specified, weld bevels are examined by required code method after grinding/machining.

Edges and weld bevels need to be clean, dry and free from surface defects, laminations, cracks, voids, notches, etc.

These are causes for rejection unless suitable/satisfactory remedial action can be taken.

Weld repairs are carried out in accordance with the code requirements and approved by the client before welding proceeds and serious or excessive defects need to be reported.

If third party inspector is not in the hold or witness point for these stages in the ITP, will review shell and tube heat exchanger manufacture quality control report in his/her coming visit of in final inspection day.

**Third Party Inspection for Shell and Tube Heat Exchanger - Fit-Up Inspection**

Shapes and dimensions are checked in accordance with the approved WPS and drawing.

Tack welds need to be produced using the applicable WPS conditions and need to be free from defects.

Magnetic Testing (MT) or Penetration Testing (PT) may be performed in accordance with the code requirement.

**Third Party Inspection for Shell and Tube Heat Exchanger - Monitoring of Weld Conditions**

The third party inspector controls preheat heat temperature and method, Interpass temperatures, weld material control, welder and process qualifications for conformity to the code requirements.

If third party inspector is not in the hold or witness point for these stages in the ITP, will review shell and tube heat exchanger manufacture quality control report in his/her coming visit of in final inspection day.

**Third Party Inspection for Shell and Tube Heat Exchanger - Back Gouging Inspection:**

The third party inspector controls the shape and dimensions of the back gouged groove for conformity to the WPS requirement. The visual appearance need to be clean and free from defects. NDE examination needs to be done in accordance with the code requirement.

**Third Party Inspection for Shell and Tube Heat Exchanger - Inspection of Completed Weld**

After completion of all welding and grinding operations a visual examination confirms there are no harmful defects such as cracks, lack of fusion, surface porosity or exposed slag inclusions, incomplete penetration, incorrect profile of the weld, lack of leg length and overlap.

Temporary attachments are removed, ground smooth, and the areas checked for defects by MP or PT for defects.

If third party inspector is not in the hold or witness point for these stages in the ITP, will review shell and tube heat exchanger manufacture quality control report in his/her coming visit of in final inspection day.

**Third Party Inspection for Shell and Tube Heat Exchanger - Non Destructive Examination**

NDE is performed by qualified personnel to the approved techniques. The techniques available are dependent on vessel classification and the materials used.

The third party inspector checks that the correct method has been used and verifies the approved status of both the technique and the personnel.

For more detail review following articles:

ASME Pressure Vessel Joint Effeciencies

ASME Pressure Vessel RT test

**Third Party Inspection for Shell and Tube Heat Exchanger Weld Repair**

The Shell and Tube Heat Exchanger weld repairs are completed using an approved WPS method and retested accordingly.

All repairs need to be approved before any post weld heat treatment is carried out.

**Third Party Inspection for Shell and Tube Heat Exchanger Post Weld Heat Treatment**

The third party inspector reviews the post weld heat treatment record of temperature and time in accordance with the approved code/procedure.

Similarly the results of hardness tests are reviewed in accordance with the code requirements.

**Third Party Inspection for Shell and Tube Heat Exchanger Mock-Up Test of Tube to Tube-Sheet Weld**

Mock-up test is made when required by purchase order or contract. Identification, visual appearance and dimensions, weld control, PT, section of weld, Macro-observation, hardness check of weld metal and heat affected zone are checked as required.

**Third Party Inspection for Shell and Tube Heat Exchanger Visual and Dimensional Inspection of Tubes, Tube Bundle and Shell**

The third party inspector carries out following controls:

- Tubes after bending for thinning particularly on the back of bends.
- Tube sheet and baffle plate, including tube hole, heads, flanges, tubes, flange facing finish.
- Channel, shell, floating head, cover, tube bundle assembly.
- Template check of shell is performed in accordance with the applicable specifications as required. Size and construction of template are to be checked, and the template pass smoothly, without binding through the full length of the shell.
- Direction and orientation of nozzle, impingement baffles, lugs and external, internal fittings are checked.
- Out of roundness, diameters, length, wall thickness, straightness of shell are checked.
- Expansion ratio of tube ends is checked. Tubes to be checked for thinning after expansion.

- U-tubes are formed from a single length having no circumferential welds, and flattening need not exceed 10% of the nominal OD of tube.

- Tube sheet flatness on gasket contact surface is checked as required.

If third party inspector is not in the hold or witness point for these stages in the ITP, will review shell and tube heat exchanger manufacture quality control report in his/her coming visit of in final inspection day.

**Third Party Inspection for Shell and Tube Heat Exchanger Tube Bundle Insertion**

Tube bundle insertion is checked as required. Cleanliness, insertion without binding, contact of tube sheet and shell flange and gasket used need to be confirmed.

**Third Party Inspection for Shell and Tube Heat Exchanger Pneumatic Test**

The third party inspector witnesses low pressure pneumatic test for nozzle reinforcing pads, support saddles or other attachments when specified by approved low pressure pneumatic test procedure using soapy water as the indicating medium.

A minimum of 1 gauge with correct working ranges as described by the code need to be used.

**Third Party Inspection for Shell and Tube Heat Exchanger Hydrostatic Testing:**

The third party inspector witnesses shell side and tube side hydrostatic testing as below points:

- Calibration status and correct working ranges of gauges. A minimum of 2 pressure gauges are attached to item under test.
- Adequate provision for venting of high points and draining are provided.

- Test pressure is applied as directed by procedure or code until test limiting pressure is reached. During hold period, a methodical check for leaks is conducted.

- Test pressures, metal and water temperatures are recorded.

- Water quality is as specified.

Special requirements of the purchaser's specification for deflection or strain gauges or pressure/time/temperature recordings is examined by the inspector and records verified.

For more detail in hydrostatic testing review Vessel Pressure Testing article.

**Third Party Inspection for Shell and Tube Heat Exchanger - Final Inspection**

After hydrostatic testing, the vessel need to be thoroughly drained and dried out by approved methods.

All internal fittings, attachments, coatings or other requirements need to be completed.

Specified post hydrostatic test NDE need to be completed and the heat exchanger closed.

All Shell and Tube Heat Exchangers are checked for cleanliness and dryness by an approved method.

The third party inspector rechecks nozzle, saddle and bracket locations and orientations against assembly drawings.

**Third Party Inspection for Shell and Tube Heat Exchanger - Name Plate Checking**

The content of the marking is checked in accordance with approved drawing and specifications by the third party inspector. Name plate need to be mounted on bracket welded to shell at the height specified.

**Third Party Inspection for Shell and Tube Heat Exchanger Painting and Coating**

Surface preparation for painting is checked for the following points, according to specification by third party inspector:

- Cleaning method (Blast or scraping and wire brushing)
- Preparation grades
- Freedom from weld spatter, blow-holes and other defects
- Dry film thickness is checked according to specification

Surface condition need to be free from pin-holes, runs damage and other discontinuity

**Third Party Inspection for Shell and Tube Heat Exchanger Spares and Accessories:**

The third party inspector controls spares, tools and accessories and make visual and dimensional inspection for materials, workmanship and quantity according to purchase order specification and packing list.

Marking and/or Tag need to be checked for identification.

**Third Party Inspection for Shell and Tube Heat Exchanger - Reporting:**

Third party inspector provides Inspection Visit Report (IVR) after each visit as well as a final report summarising the activities carried out during the vessel production in accordance with the contract requirements and circulated within the time limits specified in the contract.

The report is in the format required by the client and clearly indicates final acceptance or rejection of the Shell and Tube Heat Exchanger.

**Third Party Inspection for Shell and Tube Heat Exchanger - Release Note:**

When required by the contract or purchase order a release note is issued by third party agency and given to the manufacturer when the Shell and Tube Heat Exchanger have been finally accepted.

**Third Party Inspection for Shell and Tube Heat Exchanger Packing, Marking and Shipping:**

The following points are checked by the third party inspector:

- Cleanliness and dryness of Shell and Tube Heat Exchangers
- Rust prevention for all machined surfaces
- Protection for cover for all opening and protruding parts
- Packing style and suitably for overseas transportation
- Shipping marks and other markings and notificationof welding prohibited, etc.
- Where nitrogen purge is specified the gas pressure is checked and the presence of warning notices checked.

**Third Party Inspection for Shell and Tube Heat Exchanger Final Book (Dossier)**

The following final documents are reviewed and signed off by third party inspector:

As built, drawings if required, Manufacturer's data reports, Material certificate or certified mill test reports for all pressure parts, Material list or map, Welder record for each seam or map, Heat treatment records (Temperature-time record chart during PWHT), Dimensional record, NDE records, Production test record/mock test record, Alloy verification records, (if required), Hydrostatic test record, Pneumatic test record, Hardness test record, Post weld heat treatment NDE, if specified, Name plate or other marks, Packing list and Spare parts and tool list

## Inspection and Test Plan for Shell and Tube Heat Exchanger

The inspection and test plan for shell and tube heat exchanger article provides you information about shell and tube heat exchanger inspection in manufacturing shop. The draft Inspection and test plan for shell and tube heat exchanger provided as well.

Click here if you like immediately review the Inspection & Test Plan for Shell and Tube Heat Exchanger draft sheet.

You may need to review this sheet in conjunction of Third Party Inspection for Shell and Tube Heat Exchanger article.

Click following link if you need to review general definition for Inspection and Test Plan.

Inspection and Test Plan

The ASME Code Section VIII Div. 1 or 2 requirements normally are applied for inspection and test plan in manufacturing shop.

The witness of some inspection and test by third party inspector is mandatory and cannot be waived.

Some others must only monitored and fully witnessing is not necessary, for these items, the inspection man-days etc. depends to the purchaser decision, some prefer stringent monitoring and even assign resident inspector in manufacturing shop and some others relay to quality control system of the manufacture and assign only few days for monitoring points.

These are some of inspection points which need to be witnessed, checked, monitored and reviewed by third party inspector in shell and tube heat exchanger manufacture shop.

**Inspection and Test Plan for Shell and Tube Heat Exchanger - Important Points**

- All plates need to be identified against mill test certificates at the Vendor`s works before commencement of fabrication.
- Mill inspection of materials.
- Ensuring that welding procedure and welders are qualified before commencement of fabrication.
- Checking fit-up and witness chipping-back of welded seams.
- Wherever applicable, selecting spots for radiography.
- If specified witnessing any crack detection, hardness checks, ultrasonic tests etc. Which are specified in drawing, specification, data sheet etc.
- Reviewing of radiographs (spot check)
- Witnessing all hydrostatic tests on shell and tube sides.
- Complete dimensional checking for stacked units. This is to be carried out in the full assembly stage.

- Checking that all material test certificates and where applicable, heat treatment charts are in order. Ensure that Vendor is familiar with the requirements regarding data books and see that the documentation is submitted without any delay.

- Witnessing any further test required by purchaser

- **Q. What is Mock-up Testing?**

- Tube to all tubesheet weld tests shall be provided as described below.

- Mock-up of 10 tubes about 305 mm (12") long are welded to a portion of a tubesheet, using the same welding procedure, cut and polish for macro test. The mock-up tube and tubesheet materials and thicknesses must be identical to the actual design and supplied materials.

- Perform hardness on macro surfaces on weld, HAZ and parent materials of tubesheet and tube. Hardness not to exceed BHN 200.

- A tensile pull-test of the tube and tubesheet of the mock-up must be performed to establish UTS of the failed parts. If the tube fails before the strength weld failure, UTS of the tube shall be the minimum specified value for the material of the tube. But if the weld fails, the UTS shall be a minimum specified value of UTS of the material of the tube or tubesheet, whichever is larger. Three tensile tests shall be performed, each shall be compared to the UTS of the tube or tubesheet material as described above. All three tubes for tensile pull test shall only be welded to tubesheet and not rolled.

- For the production weld, after 10 tubes have been rolled lightly (if rolling is used) and the root pass welding is completed, soap suds or halogen leak tests shall be performed on each tube well. If welding is sound, no further tubewelds need be leak tested.

- Repeated welding failures and repairs shall be subject to Purchaser's review and acceptance